# Monitoring using acoustical methods: The power of bioacoustic monitoring for studying nocturnal migration


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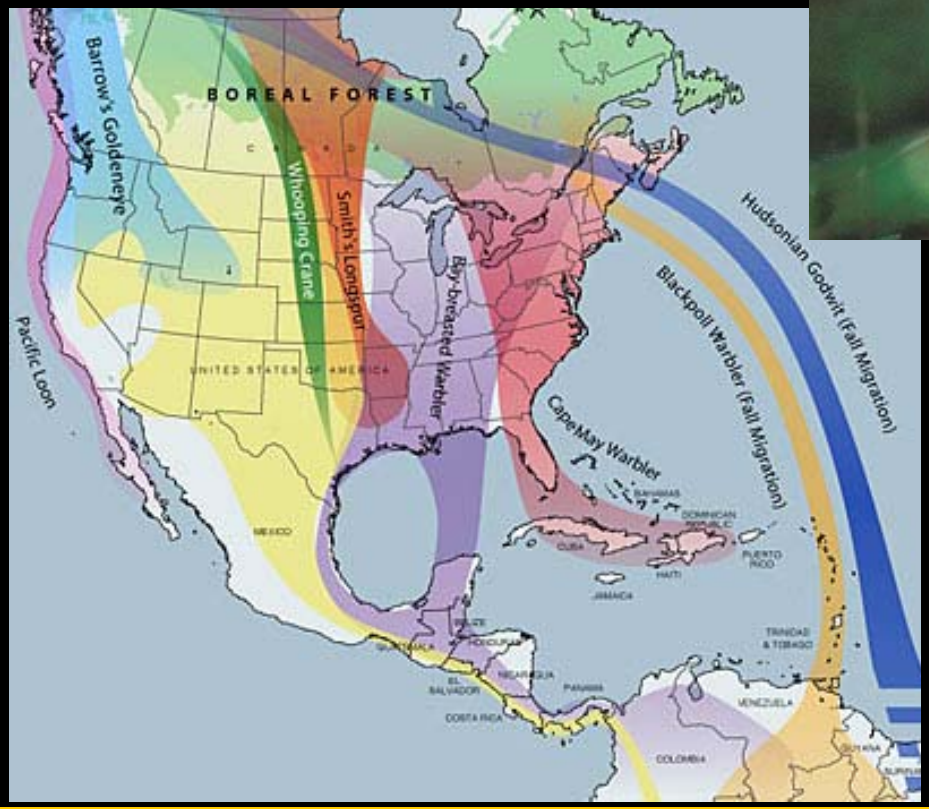
# Why study migrants and migration using acoustic technology?

Survey “boreal-breeders” that winter in Amazonia

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# Why study migrants and migration using acoustic technology?

Monitor the effects of humans activities that create new hazards for migrants

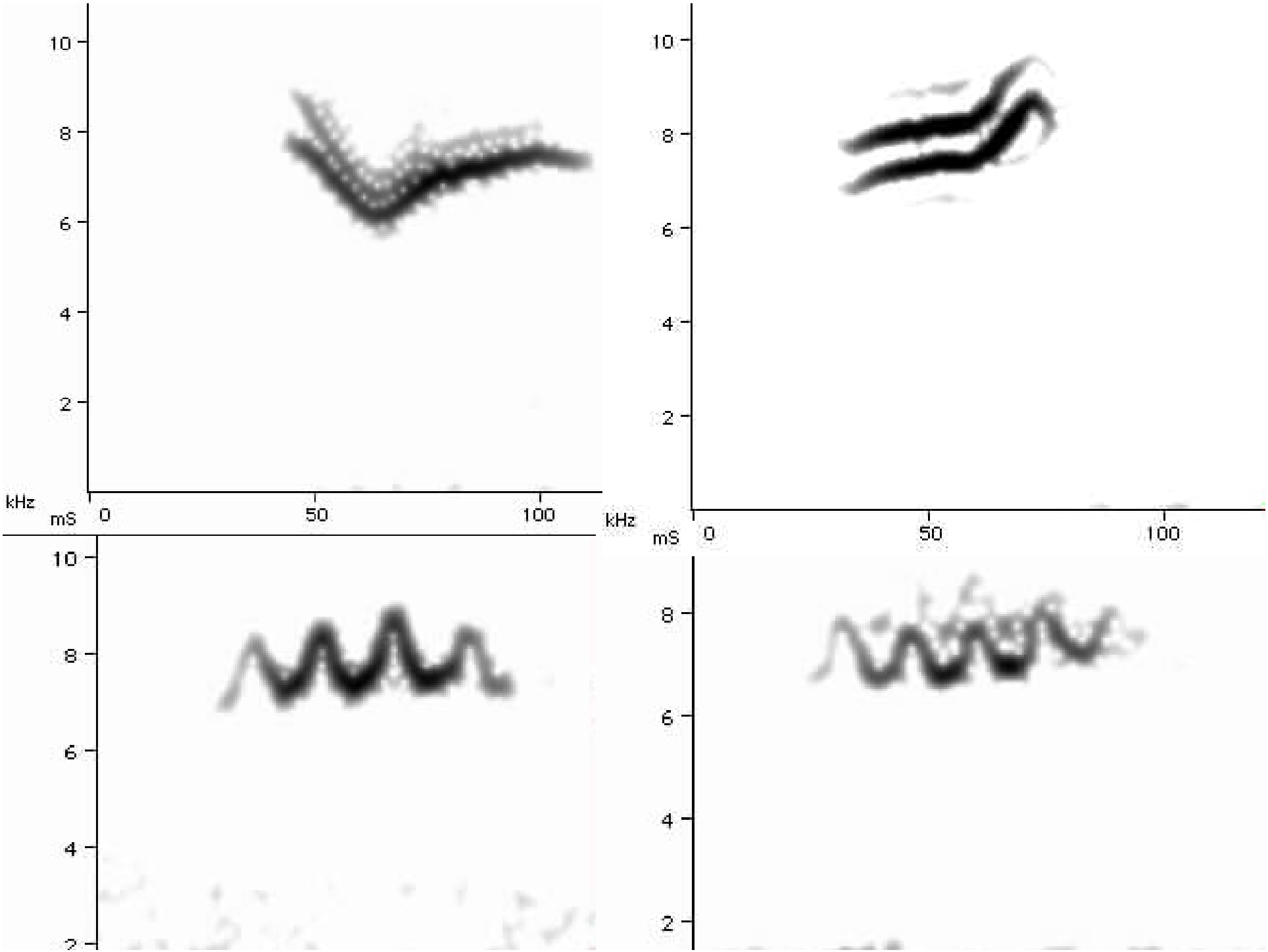
# What is a flight call?

Flight calls are primary vocalizations given in sustained flight.

Many birds produce these vocalizations, usually short (less than 300 ms) and high frequency (many above 6 kHz).

Flight calls communicate information among/within flocks.

Calls are species-specific, varying in frequency, duration, and pattern among species.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# Many species produce flight-calls.

- Evans and O'Brien (2002) covers E North America.
  - Earliest IDs from 17-18th centuries, but some IDs remain unknown until 20th century
- Flight-call identification:
  - Diurnal migration
  - Associations with migration timing
  - Recordings in captivity
- Migratory bird conservation needs flight-calls.
  - Best option for monitoring species


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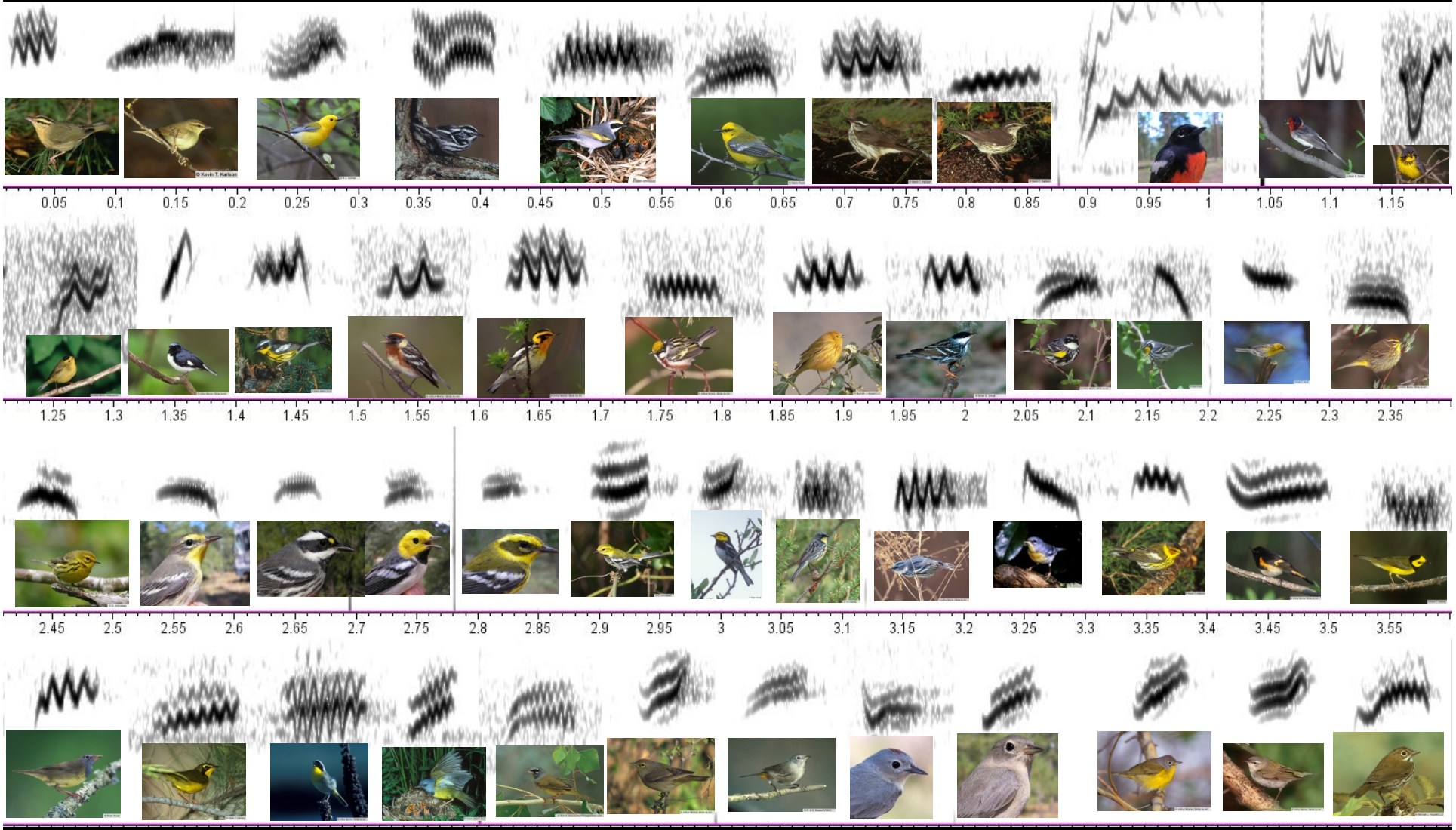
# “The Rosetta Stone. . .”

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DEPARTMENT OF DEFENSE LEGACY PROGRAM

# Recording free-flying birds: the flowerpot microphone

- 2-9 kHz sensitivity
- Detects 6-9 kHz calls (warblers, etc.) to 200-400m above ground
- Detects 2-5 kHz calls (thrushes, etc.) to 500-800m above ground

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# Recording flight-calls with ARUs

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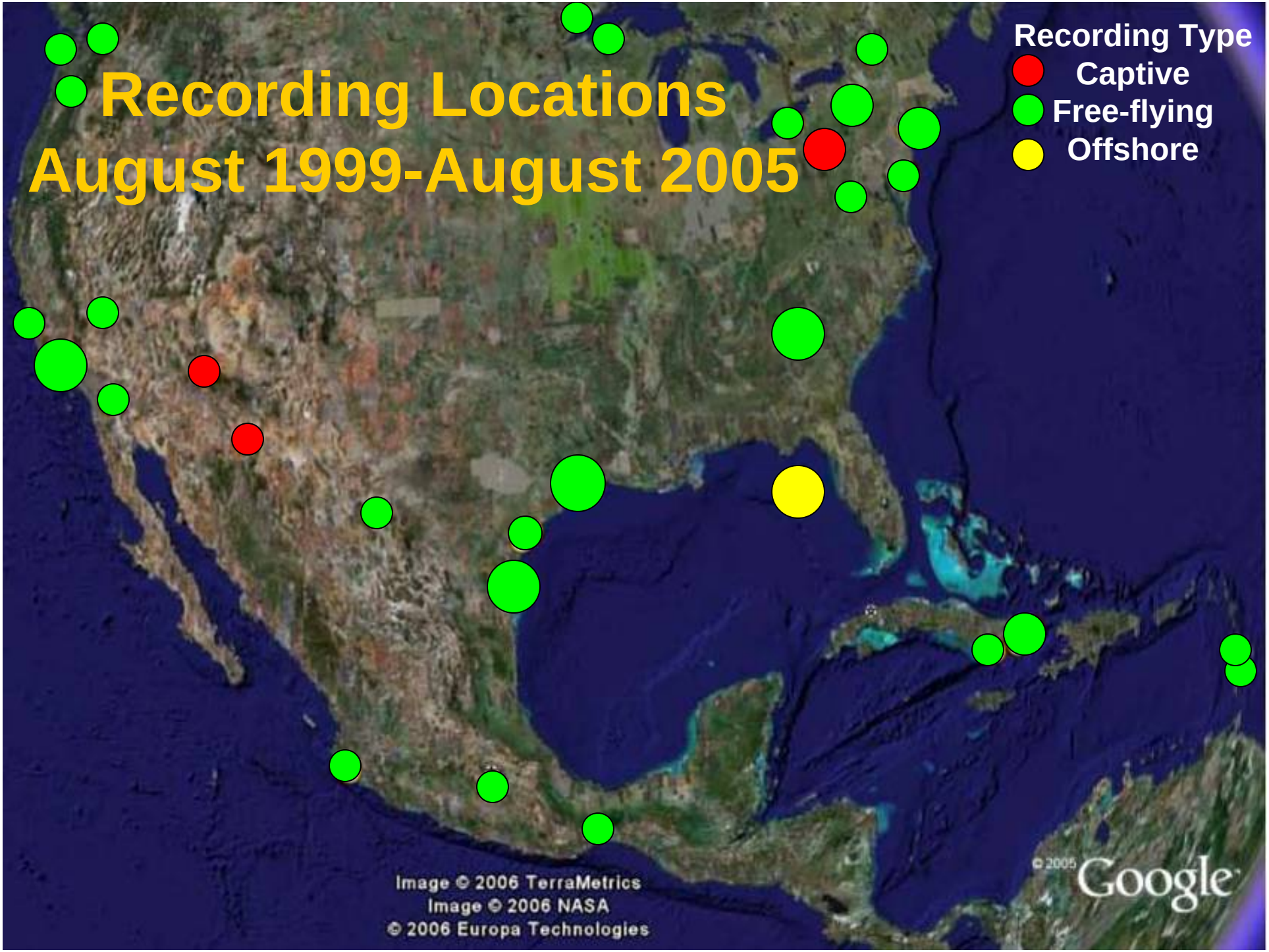
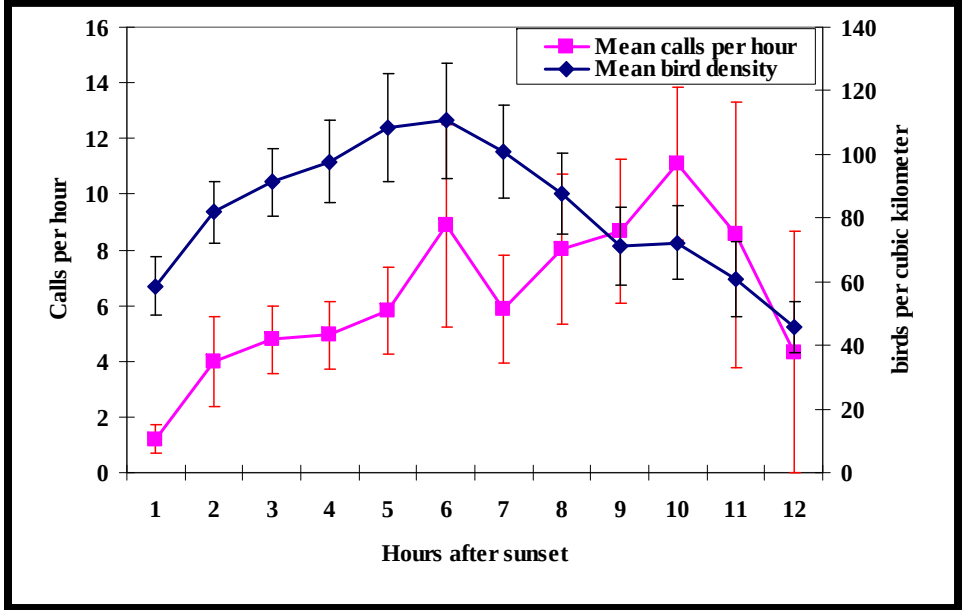
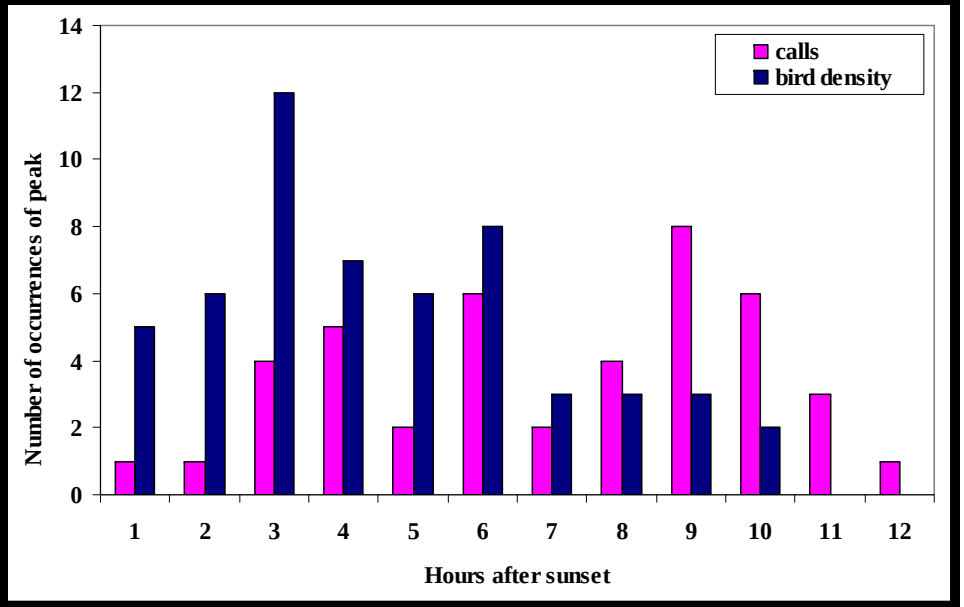

Recording Locations
August 1999-August 2005
Recording Type
Captive
Free-flying
Offshore
Image © 2006 TerraMetrics
Image © 2006 NASA
© 2006 Europa Technologies
© 2005 Google

# Patterns of bird density and flight-call counts exhibit wide variation within and among nights.




Nightly temporal pattern of bird density and flight-call counts




Frequency distribution of peaks of bird density and flight-call counts

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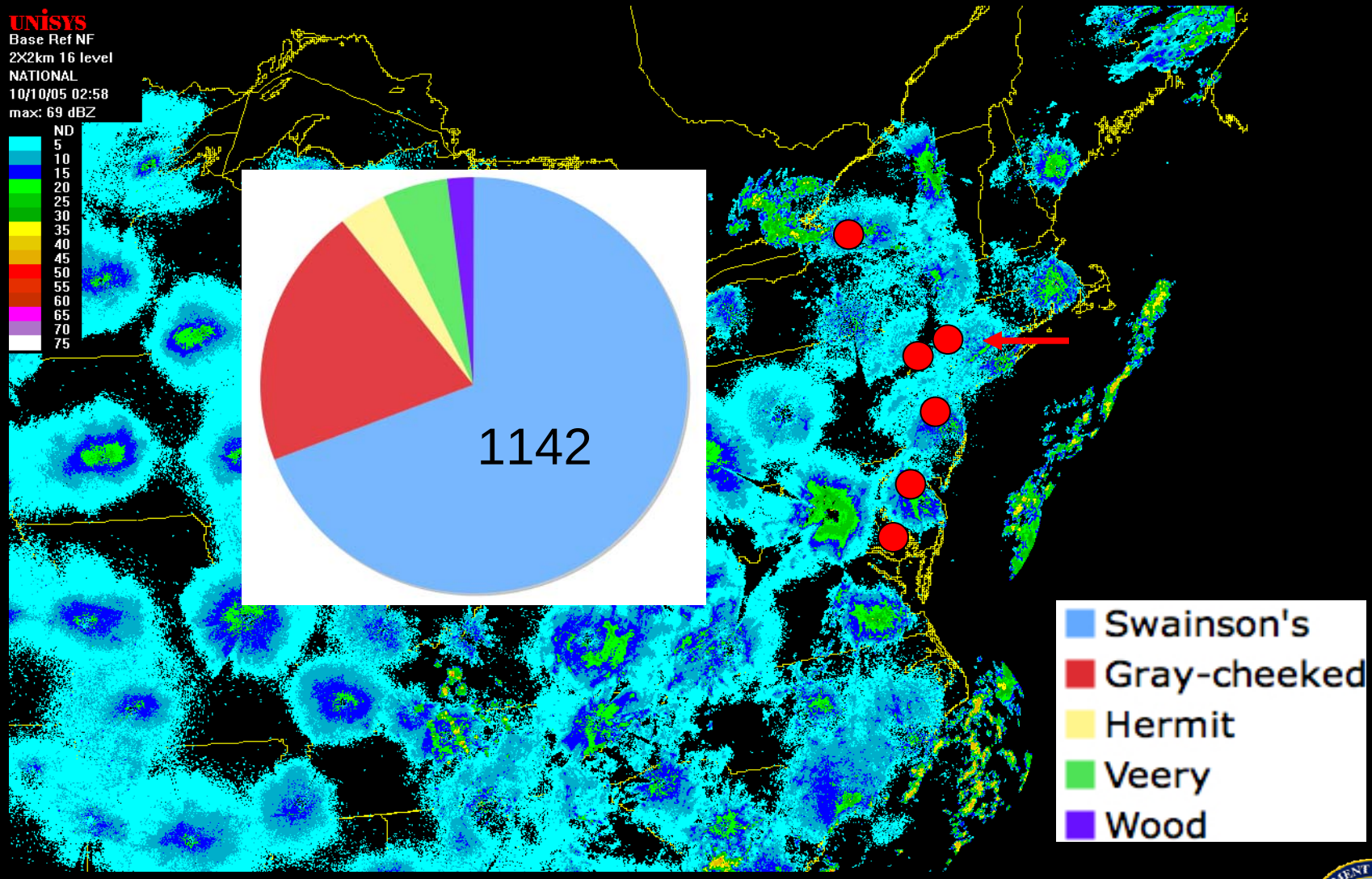
# Thrushes: 9 October, 2005 – West Point USMA

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# MMS 2005-009: Viosca Knoll Recording

OCS Study
MMS 2005-009

Coastal Marine Institute

## Interactions Between Migrating Birds and Offshore Oil and Gas Platforms in the Northern Gulf of Mexico

Final Report

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

Cooperative Agreement
Coastal Marine Institute
Louisiana State University

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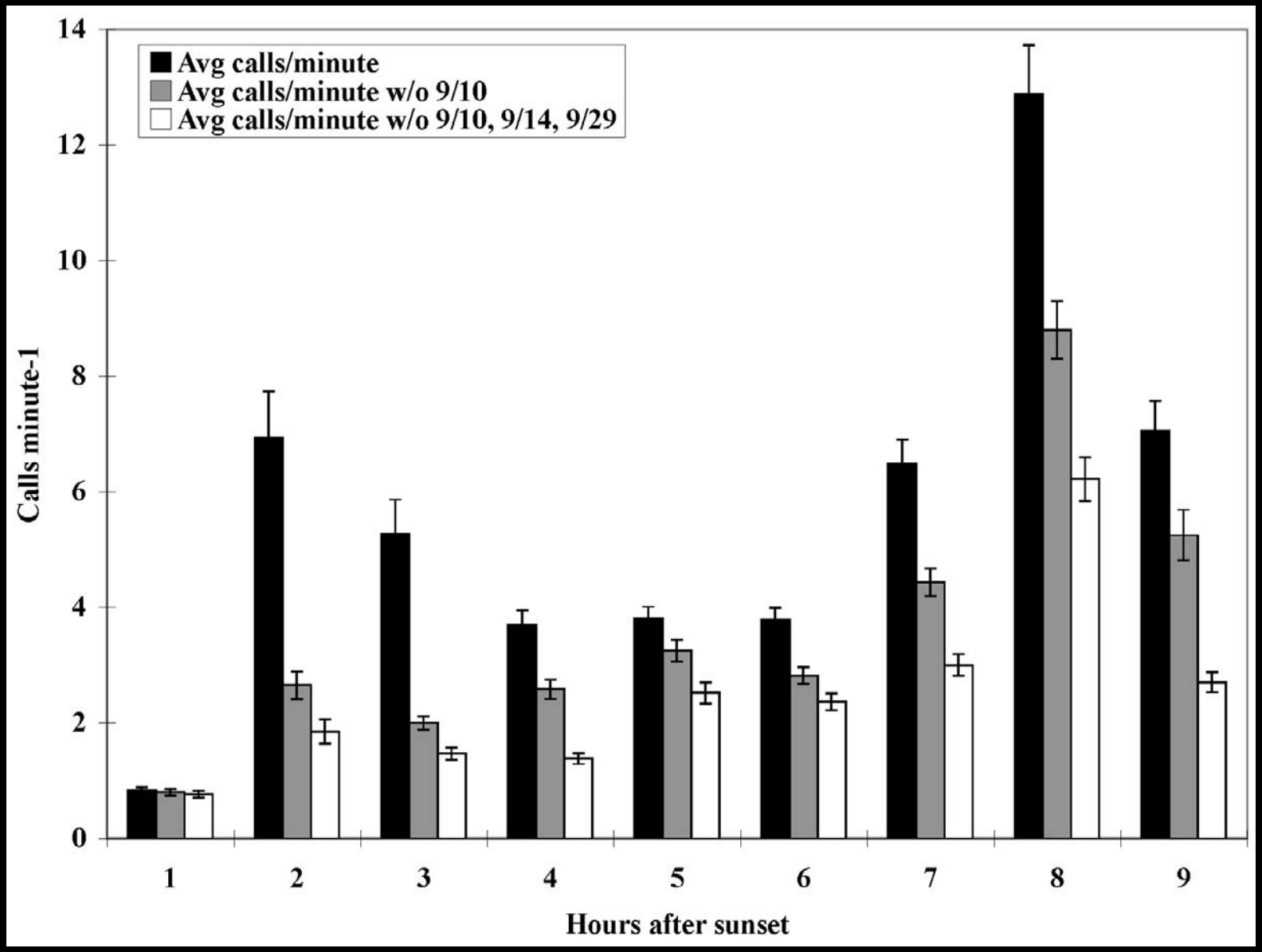
Avg calls/minute
Avg calls/minute w/o 9/10
Avg calls/minute w/o 9/10, 9/14, 9/29
Calls minute-1
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4
6
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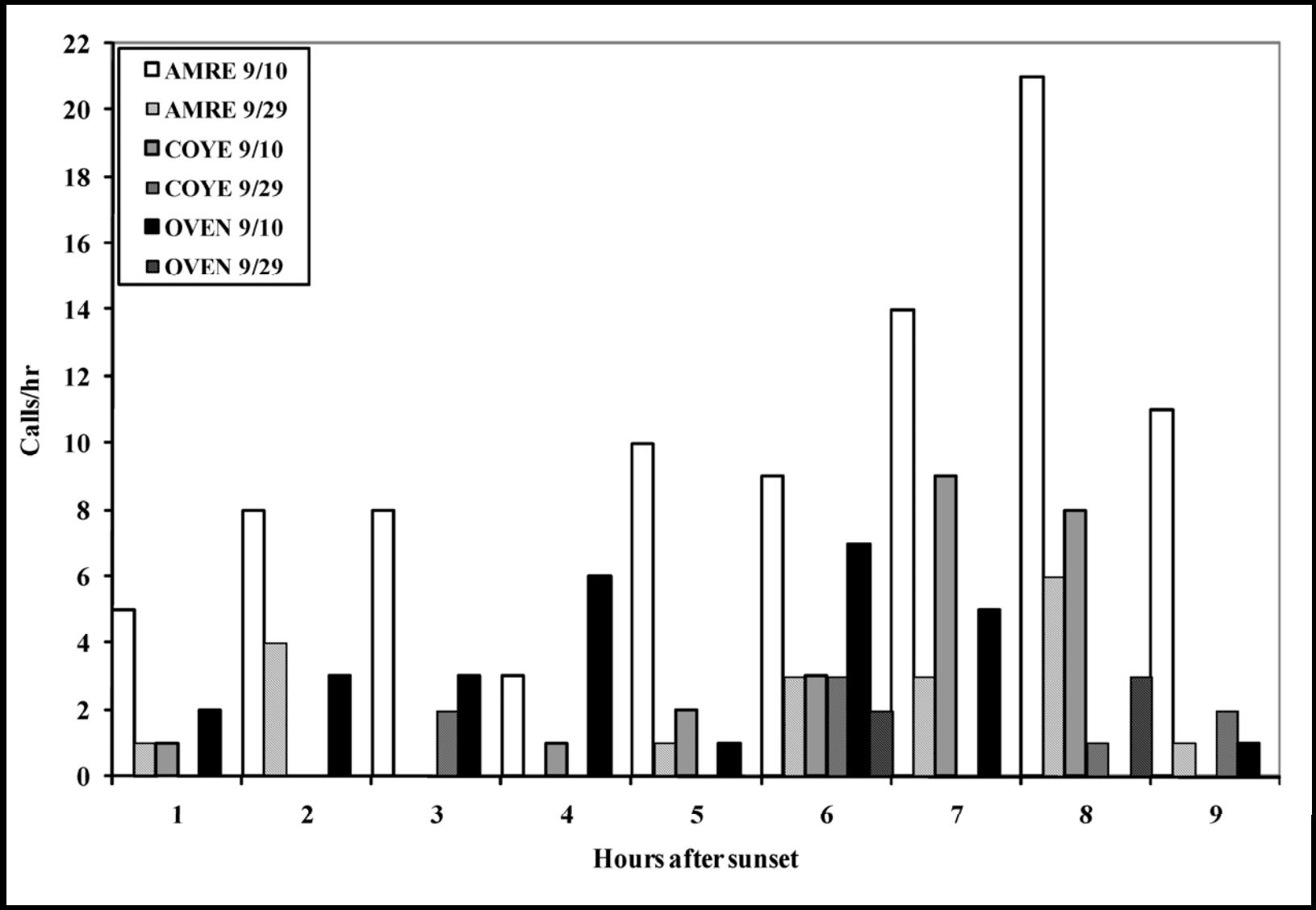
Hours after sunset

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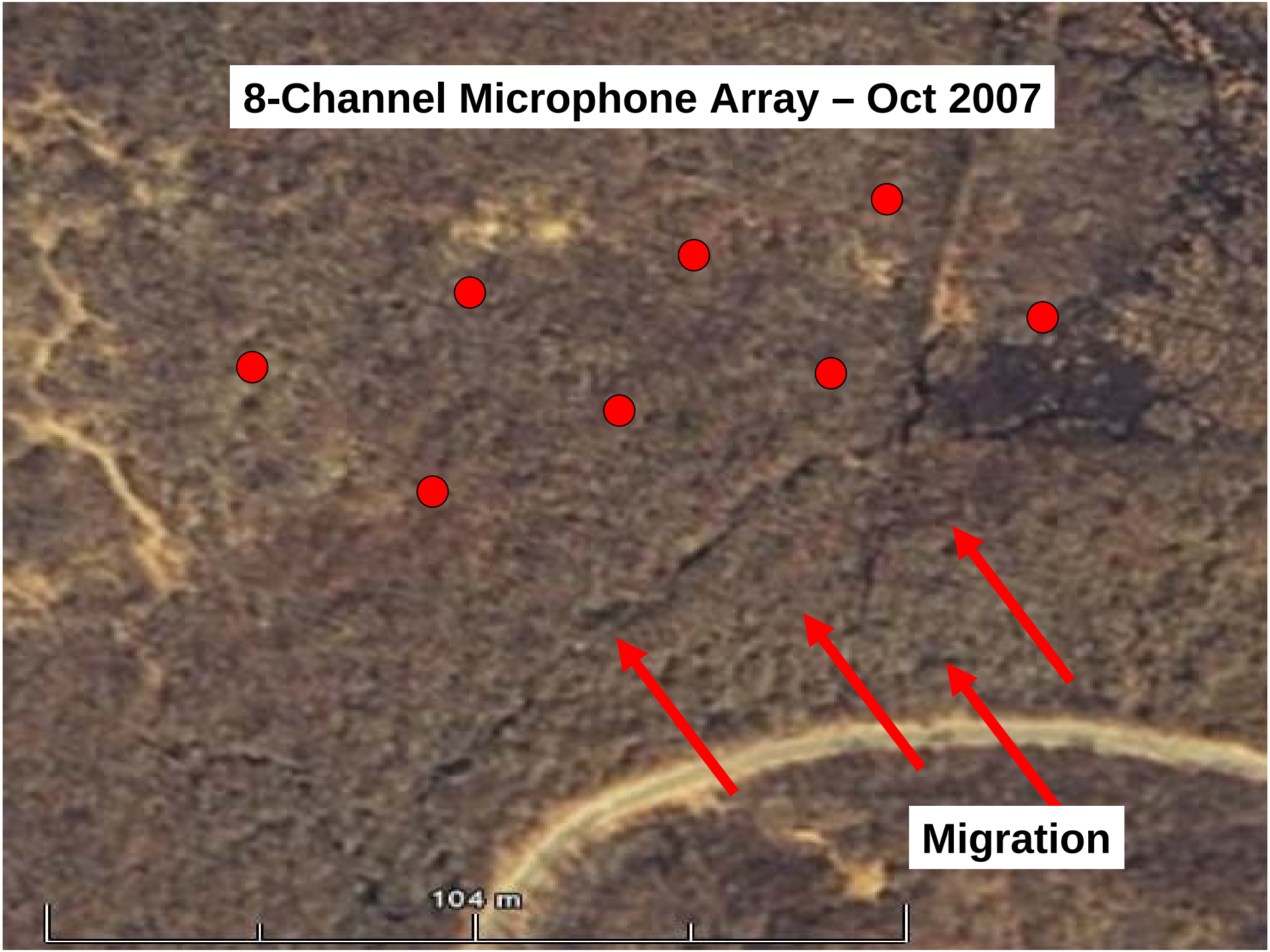
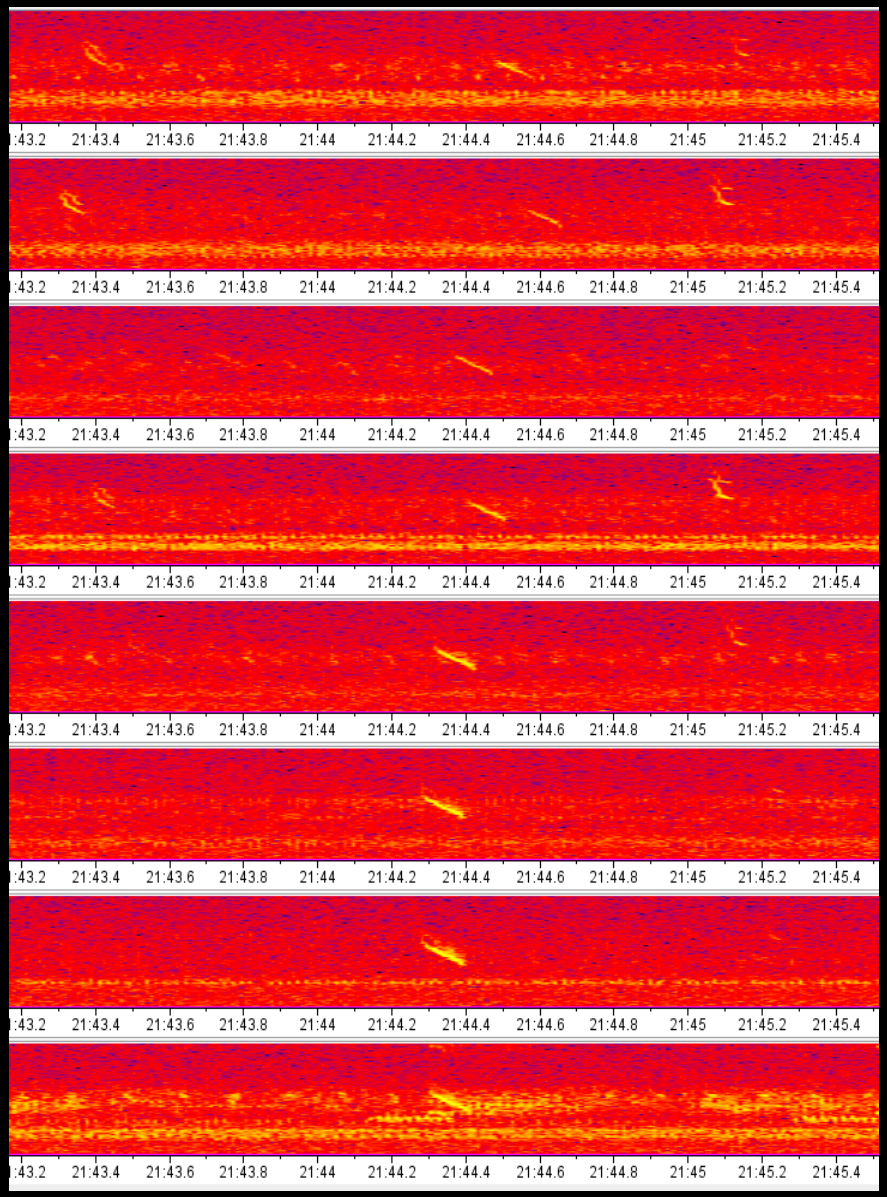
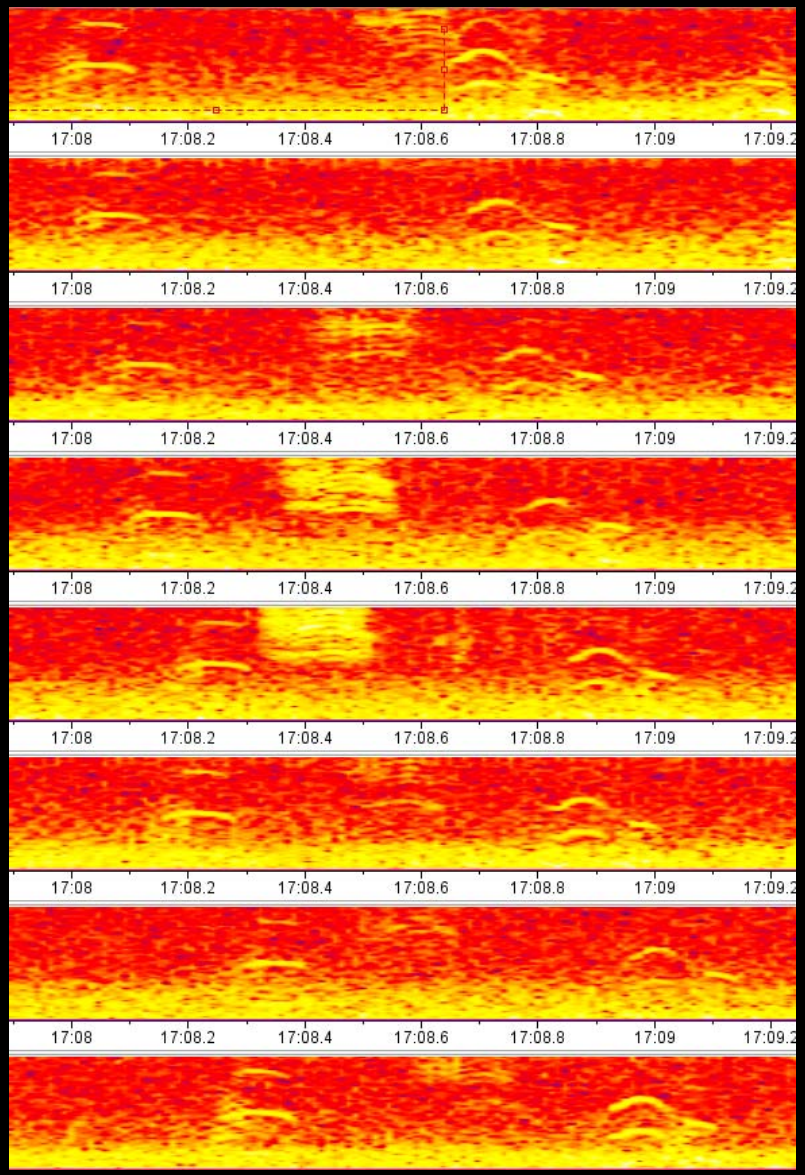

8-Channel Microphone Array – Oct 2007
Migration
104 m

# Calls on 8-Channel Microphone array – 10 Oct 2007

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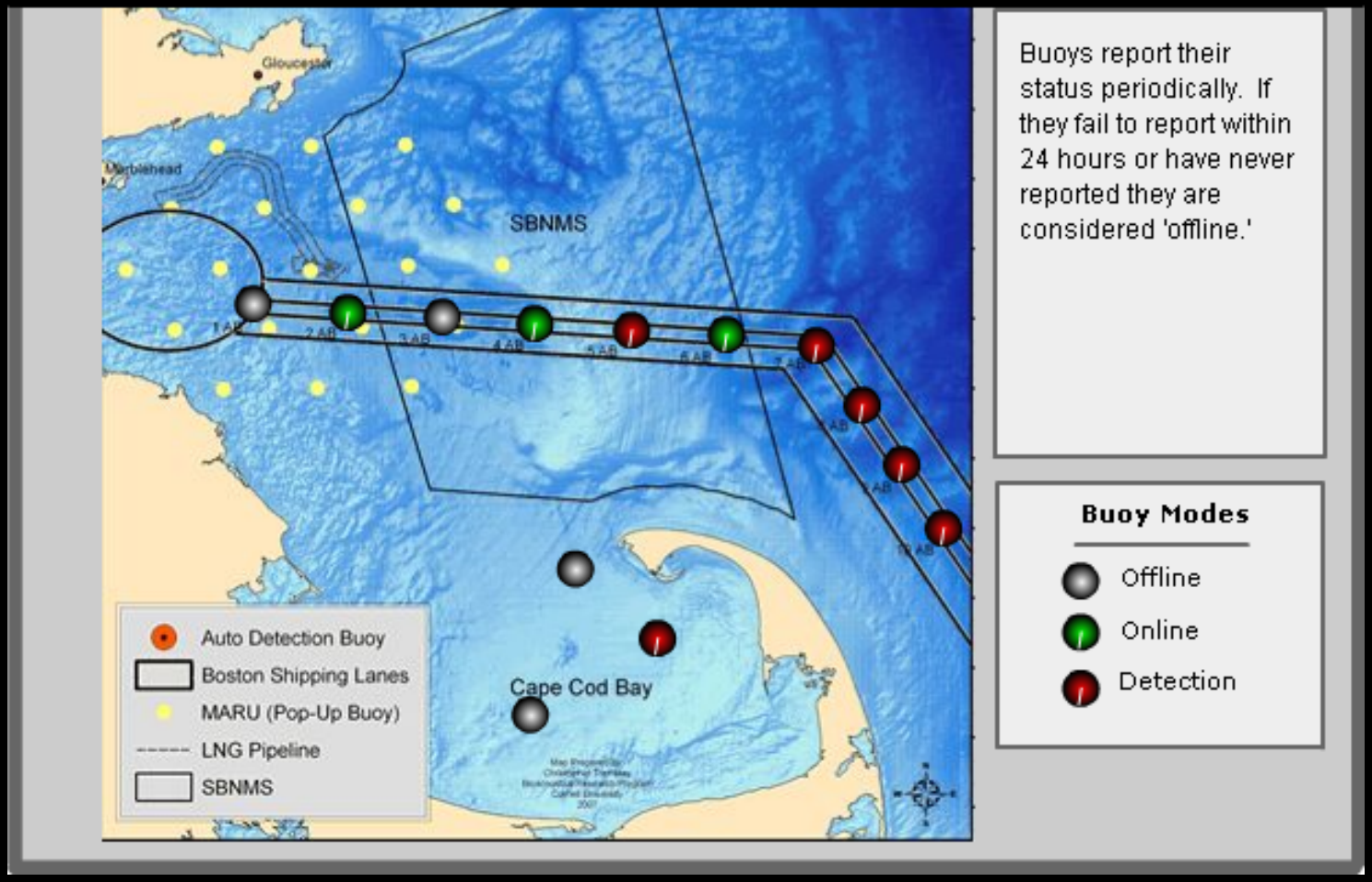
# Real-time Auto-detection Network Operating in Boston Shipping Lane

## Whales Detected

**Last Whale Heard: 2008-01-30 09:08:23 GMT on Buoy DMF1**

**Current time: 2008-01-30 16:30:25 GMT**

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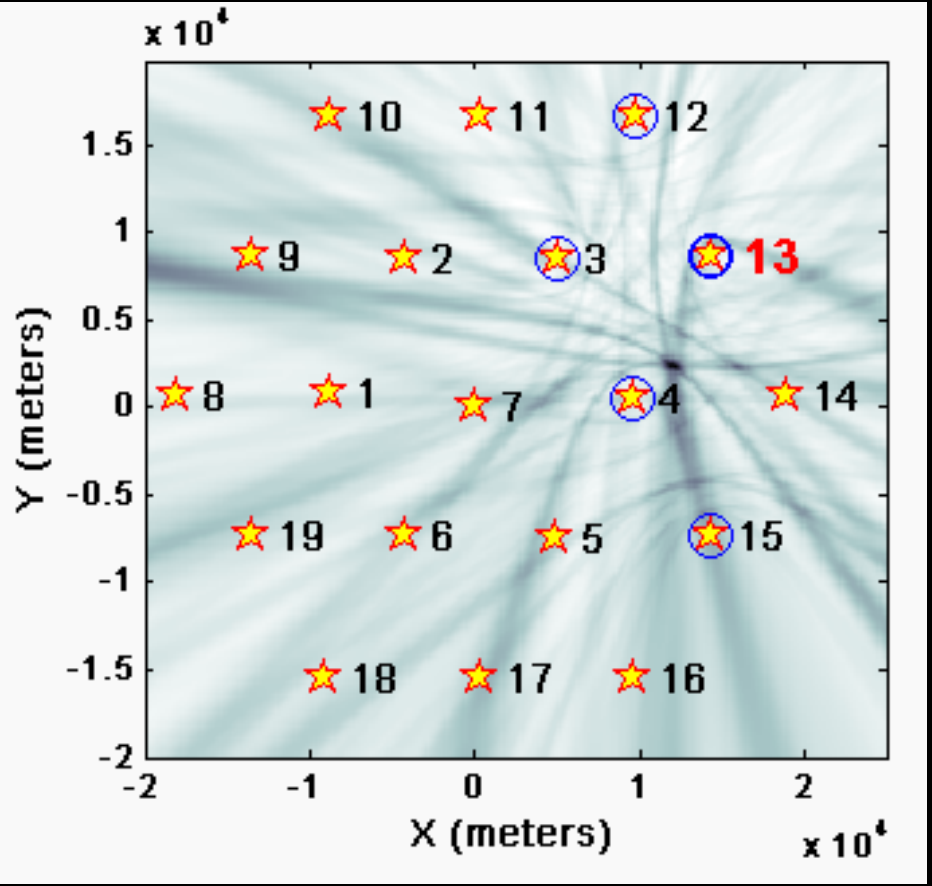
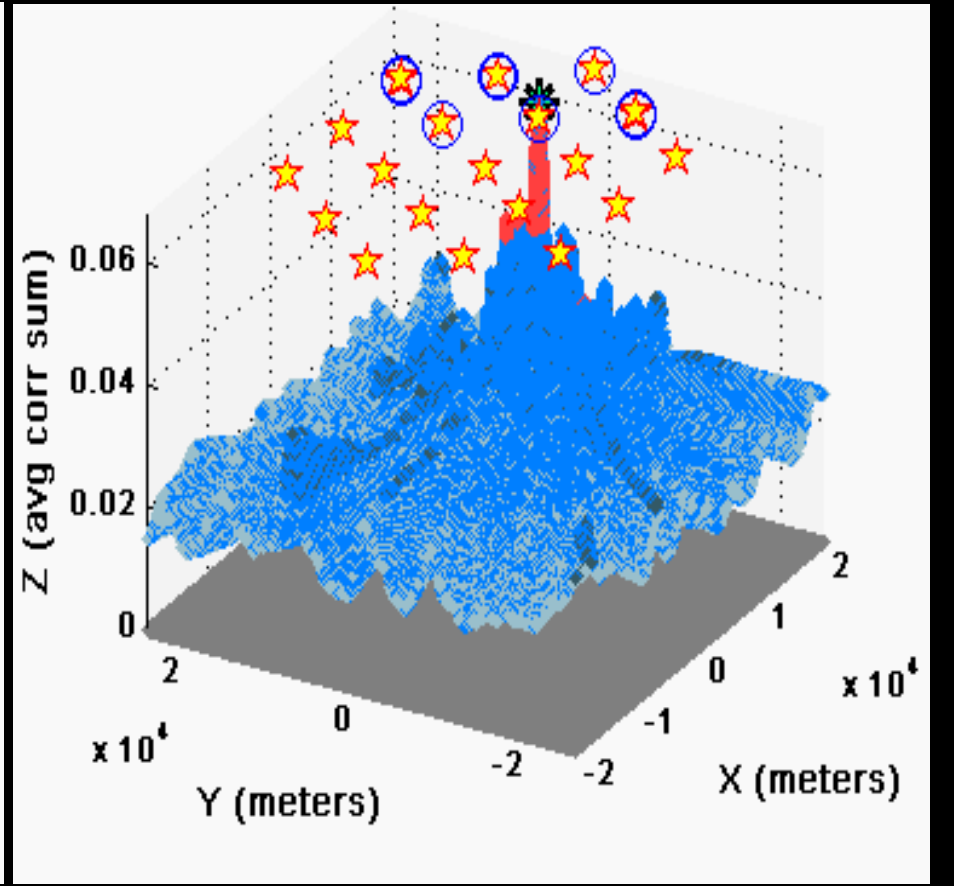
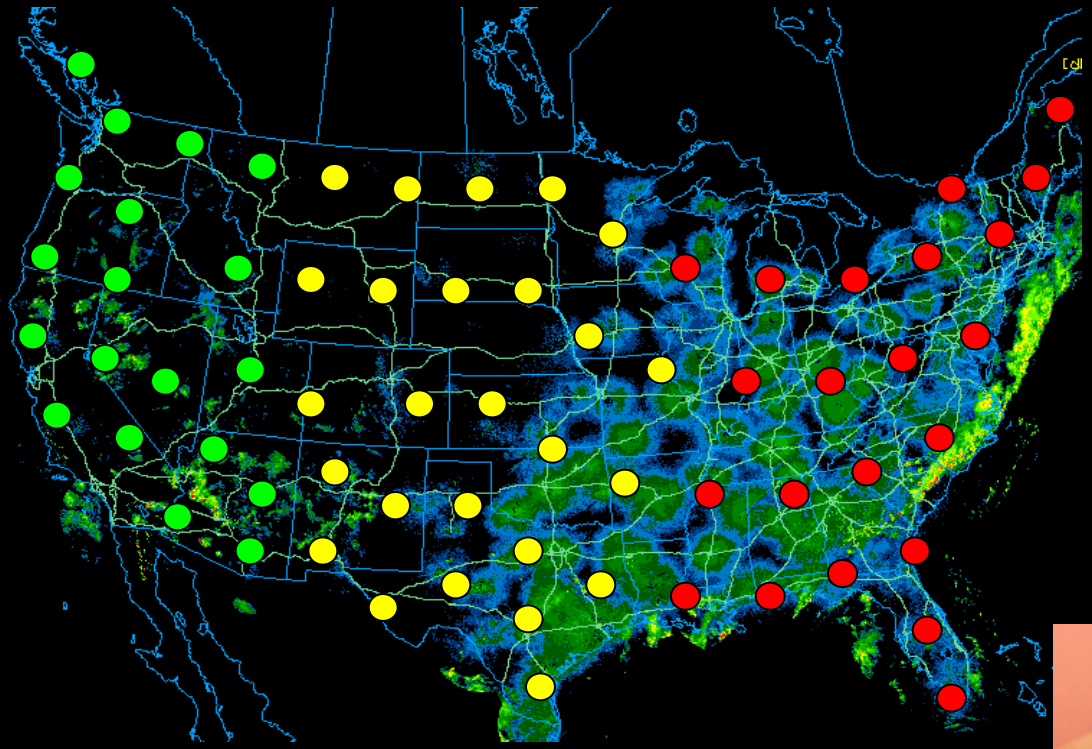
# Call Location on 19-Channel array – 14 Sept 2007



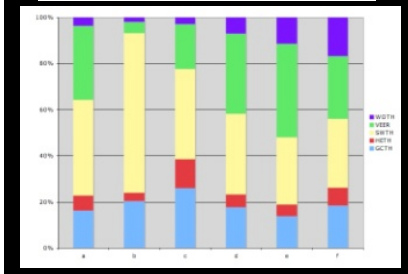



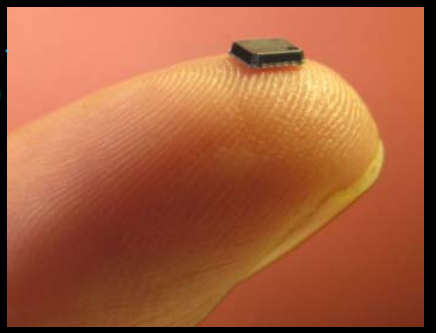
# Future plans for monitoring migrants

## Combine different technologies



ebird





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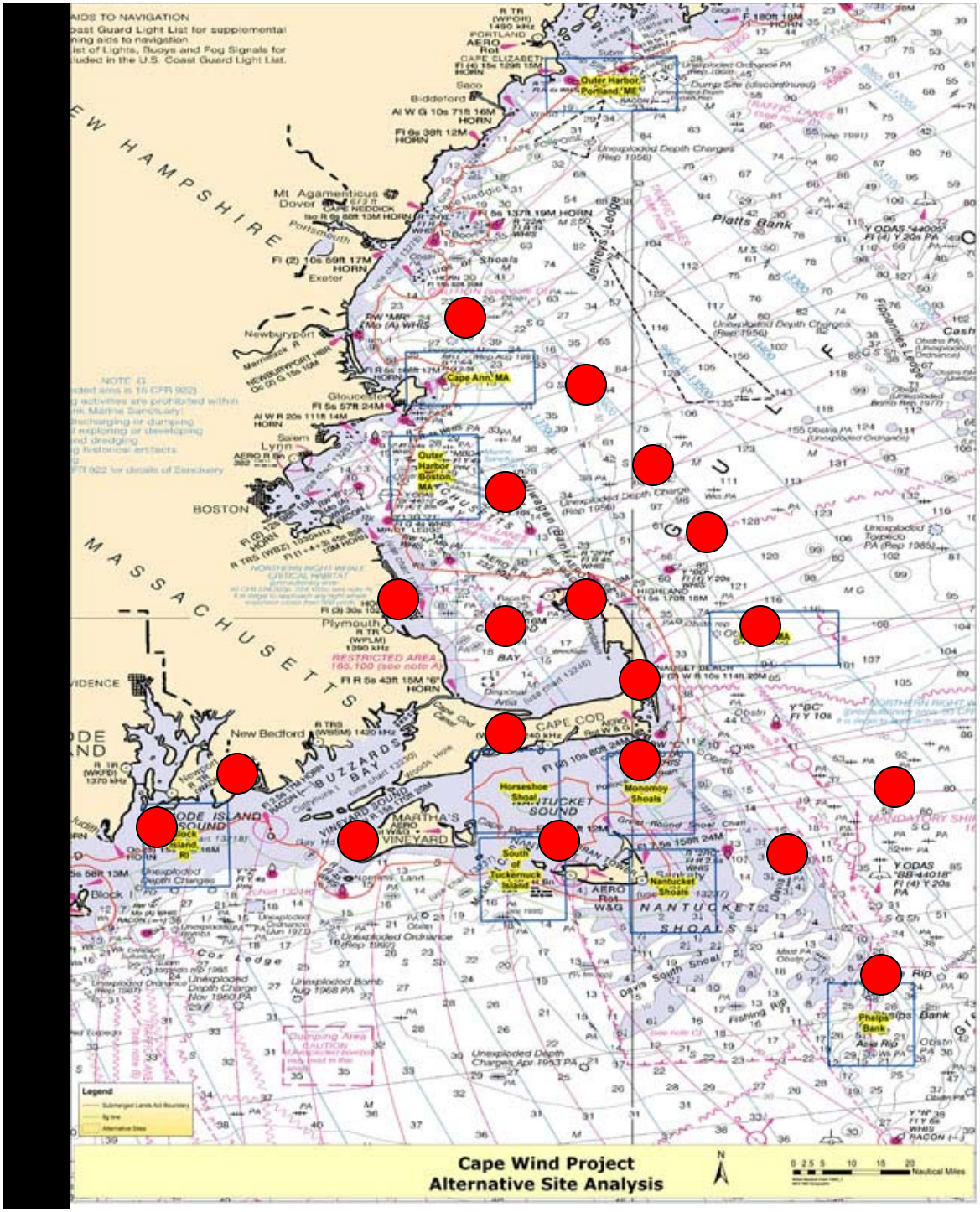


Example deployment
Offshore and Nearshore
Massachusetts

# Challenges of applying acoustic technology

- Massive amounts of data to analyze
- Accelerating pace of software development for detection and classification – automation
- Understanding detectability, localization, calling-rates
- Continued identification challenges
- Species groups that don't call
- **<u>Recording environment offshore is noisy!</u>**

# Acknowledgments


- Special thanks to Bill Evans, Michael O'Brien, and Michael Lanzone.
- Minerals Management Service (14-35-0001-30660, 1435-01-99-CA-30951)
- Department of Defense Legacy Program (05-245, 06-245, 07-245): Chris Eberly, Pedro Morales, Jane Mallory, Kyle Rambo, John Joyce, John van de Venter, Rayanne Benner, Chris Pray, Chris Dobony
- Field Crews: Powdermill Avian Research Center, Mogollon Rim, Yuma
- Cornell Laboratory of Ornithology, Bioacoustics Research Program, and Conservation Science Program
- Additional Financial Support: Kieckhefer Adirondack Fellowship, Audubon Ford Fellowship, Victor Emanuel Nature Tours, Cornell Laboratory of Ornithology (Assistantship and Anonymous Donations), Department of Ecology and Evolutionary Biology.


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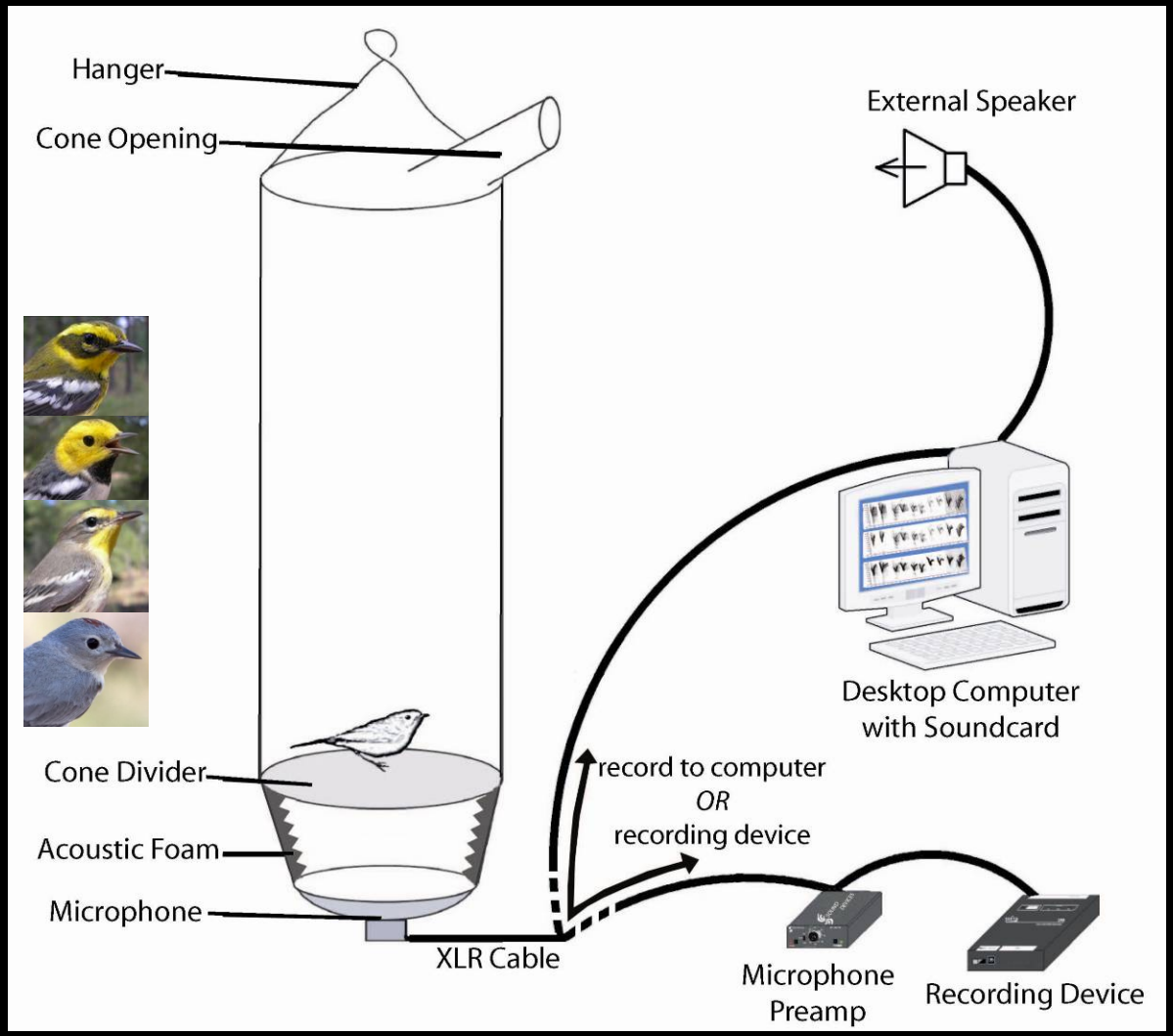
# Recording free-flying birds

# Recording captive birds: acoustic cone




Designed by Michael Lanzone (Lanzone and Farnsworth submitted)

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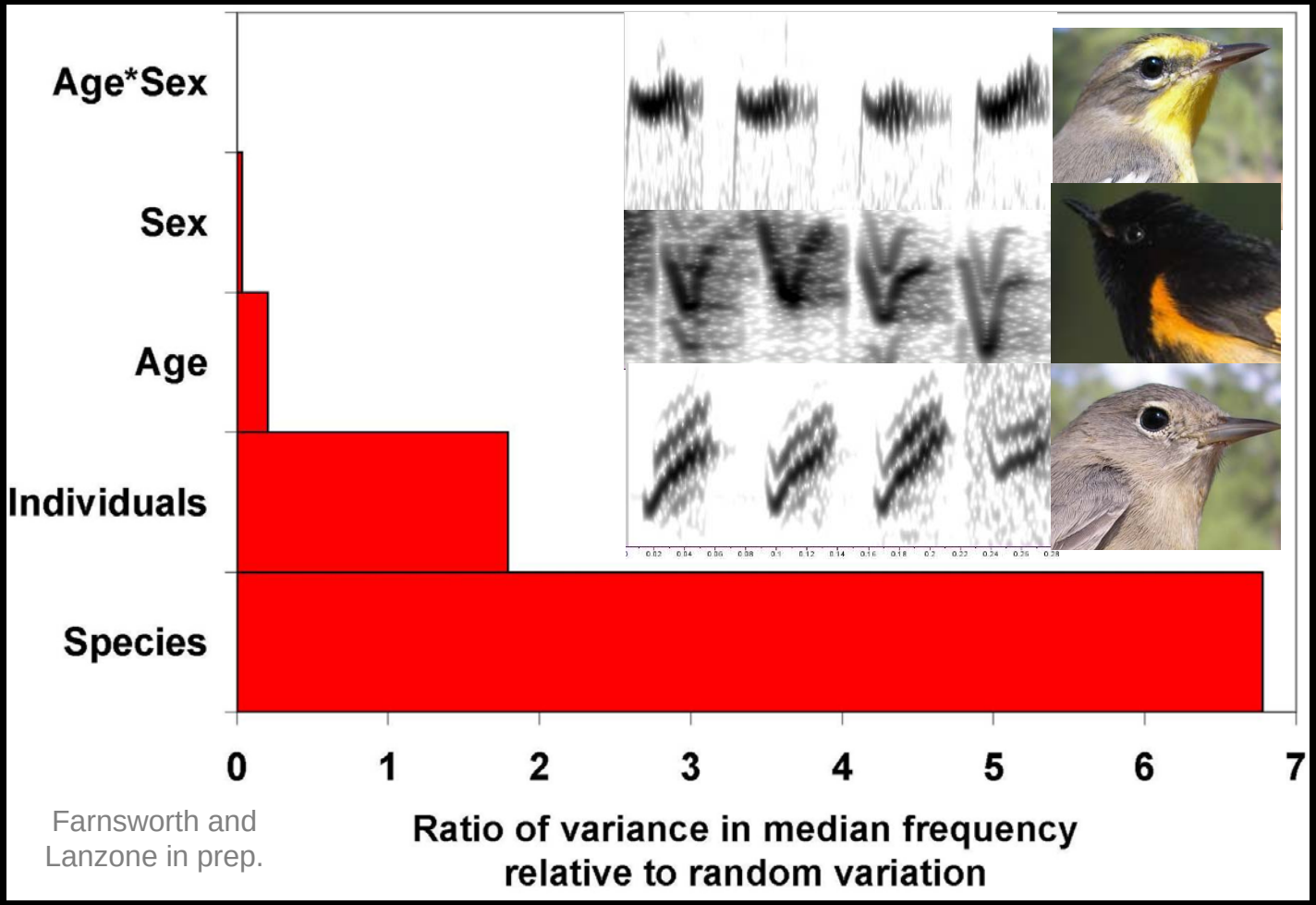
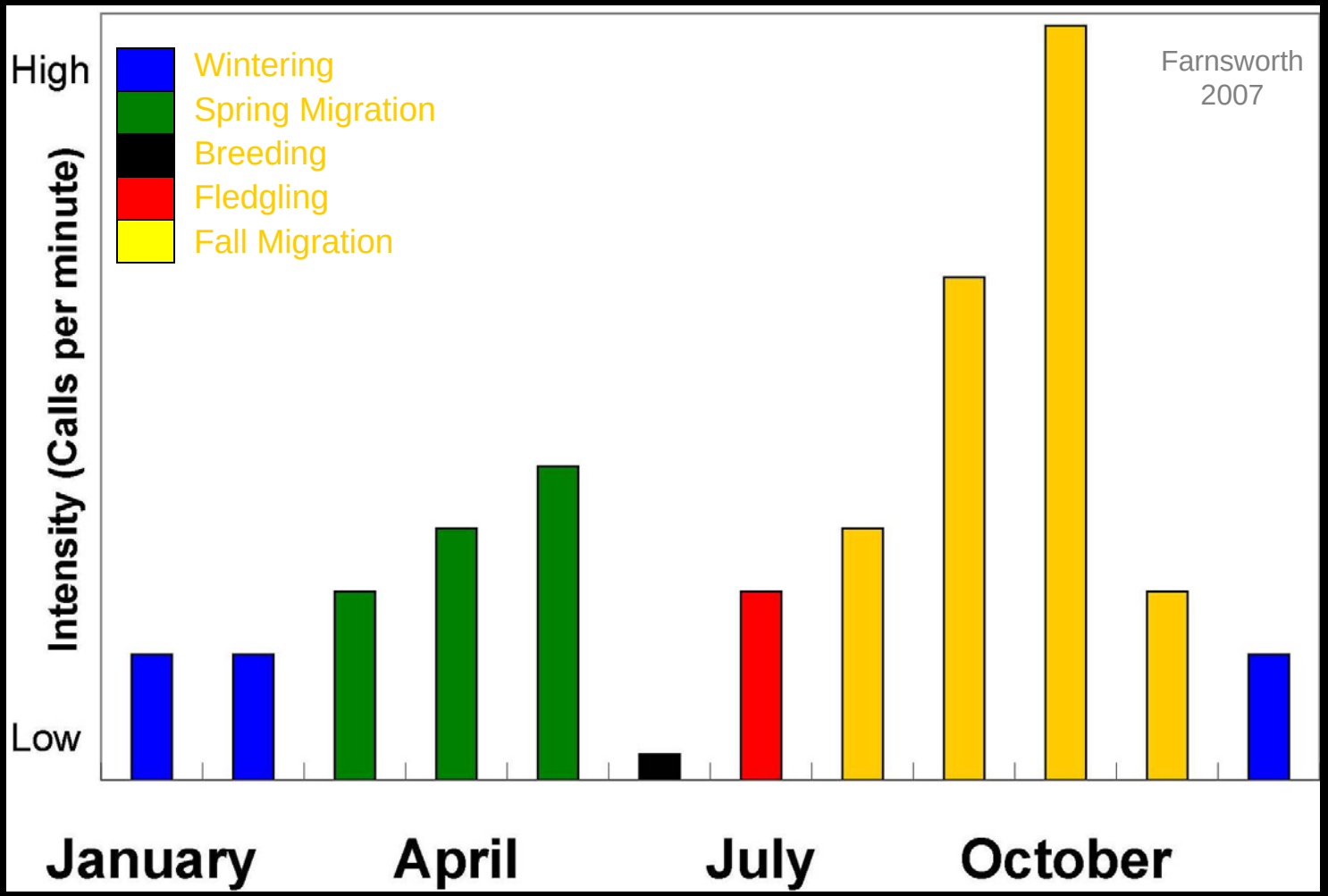
# Variation among species is greater than variation among individuals and ages and between sexes.




Farnsworth and Lanzone in prep.

# Flight-calling behavior is **not** limited to migratory periods in warblers.

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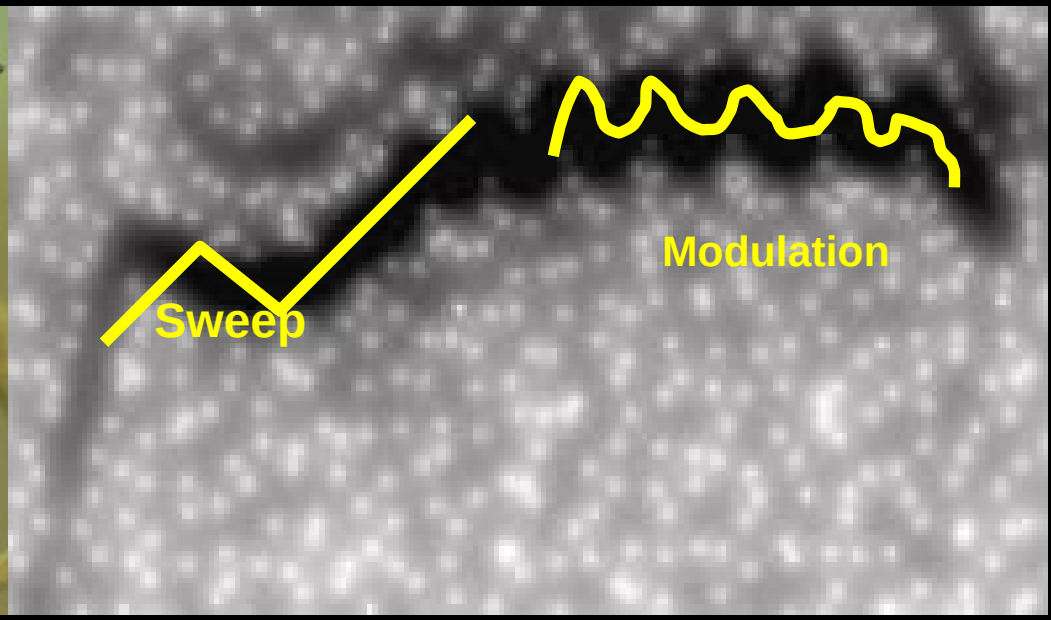
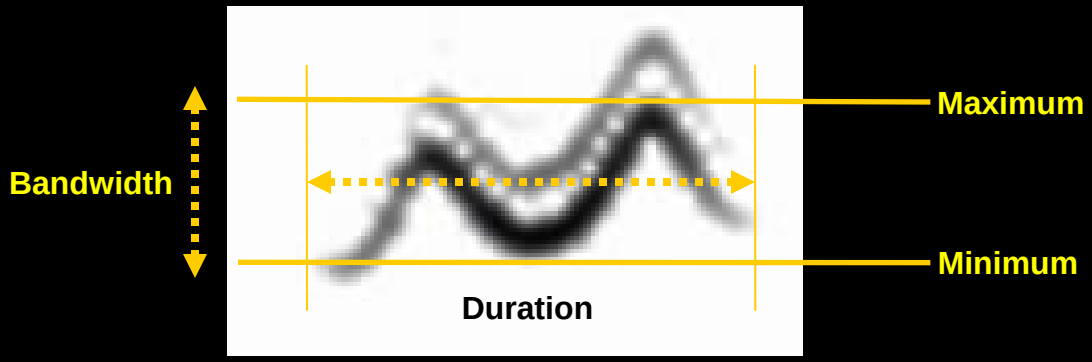
# Traditional analysis

## Syllabic measurements

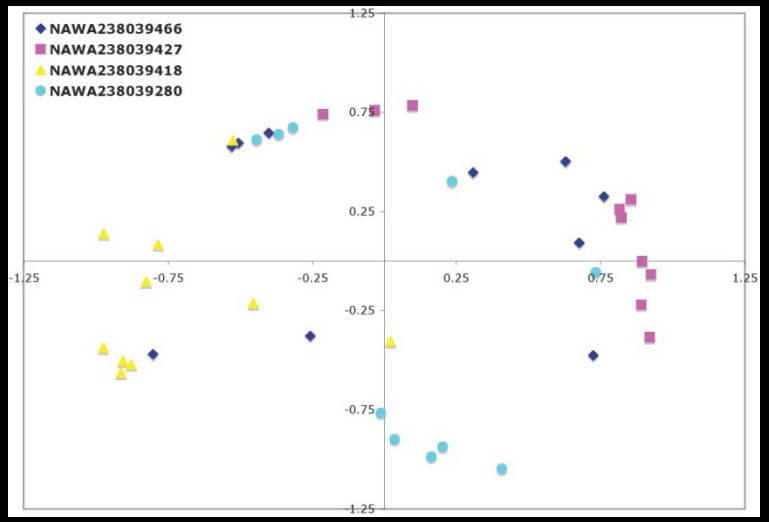



## Spectral and temporal measurements

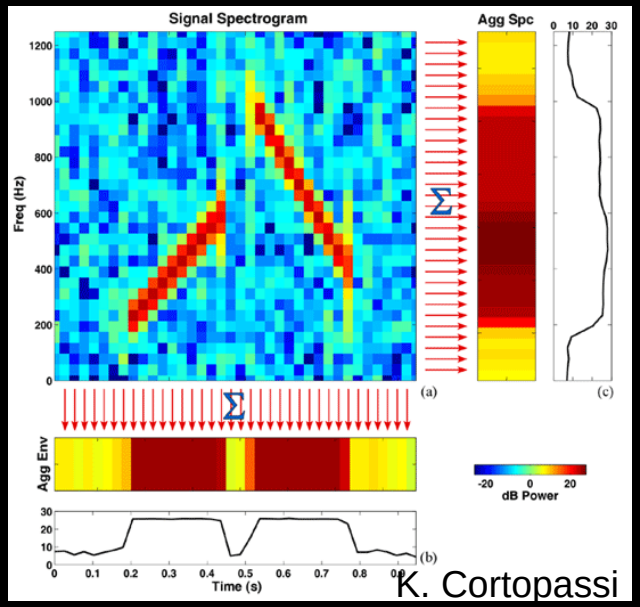



# New ways of representing flight-calls

- Spectrogram Cross Correlation
  - acoustic (particularly “syllabic”) similarity among species
  - identify flight-call “template” for each species that best correlates with remaining calls




- ACOUSTAT/XBAT
  - treat spectrogram data as probability distributions
  - characterize using order statistics (e.g. median)

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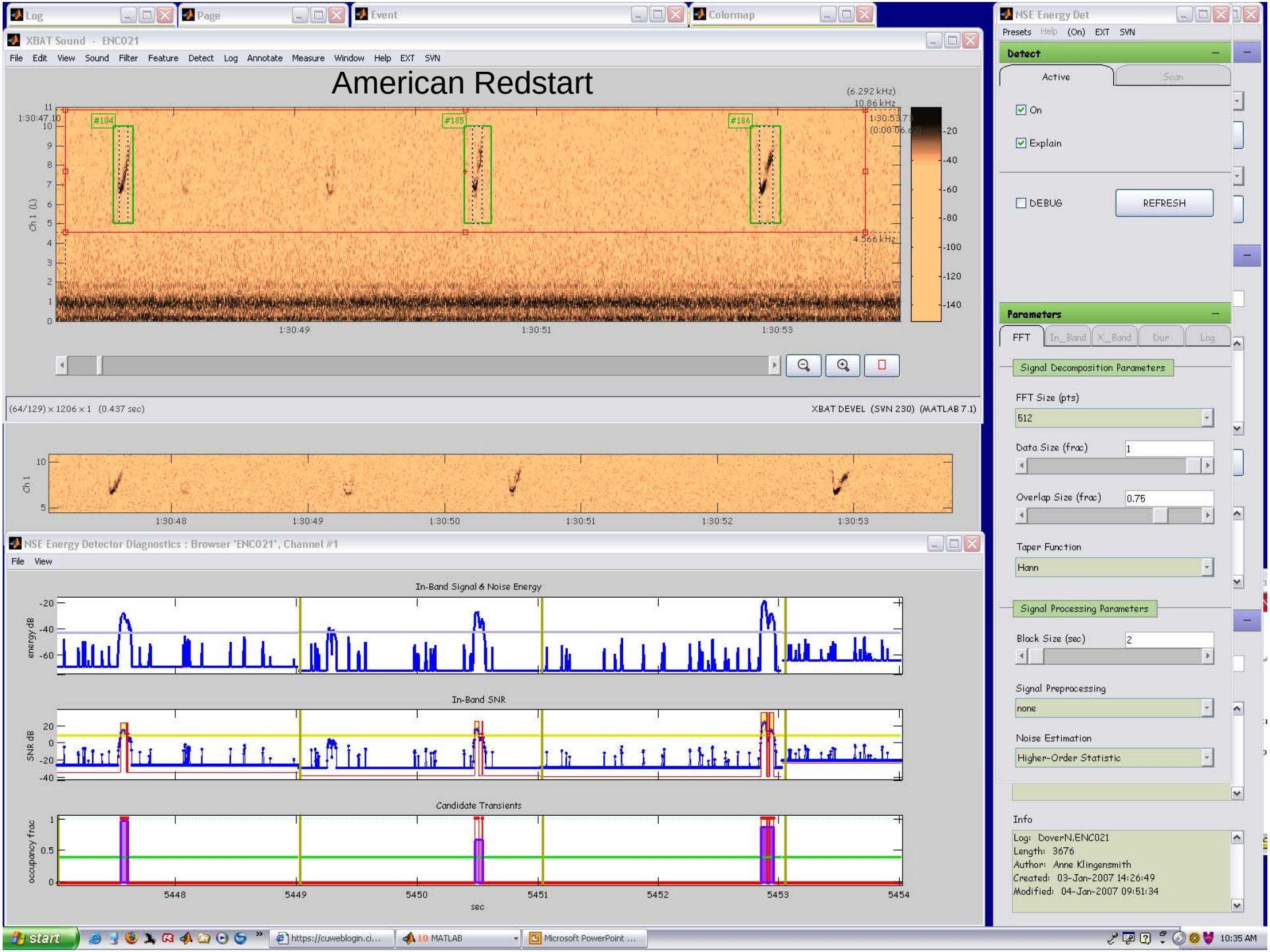
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XBAT Sound - ENC021
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XBAT DEVEL (SVN 230) (MATLAB 7.1)
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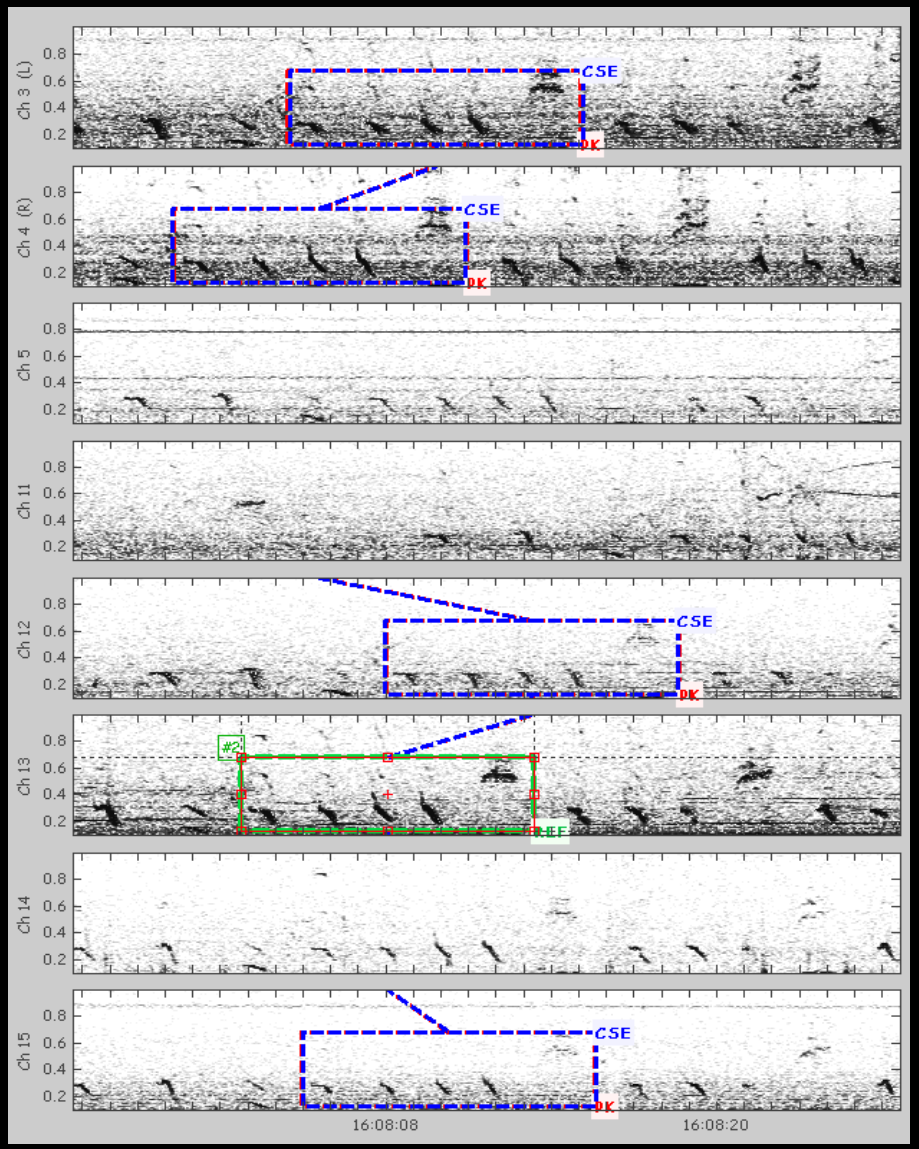
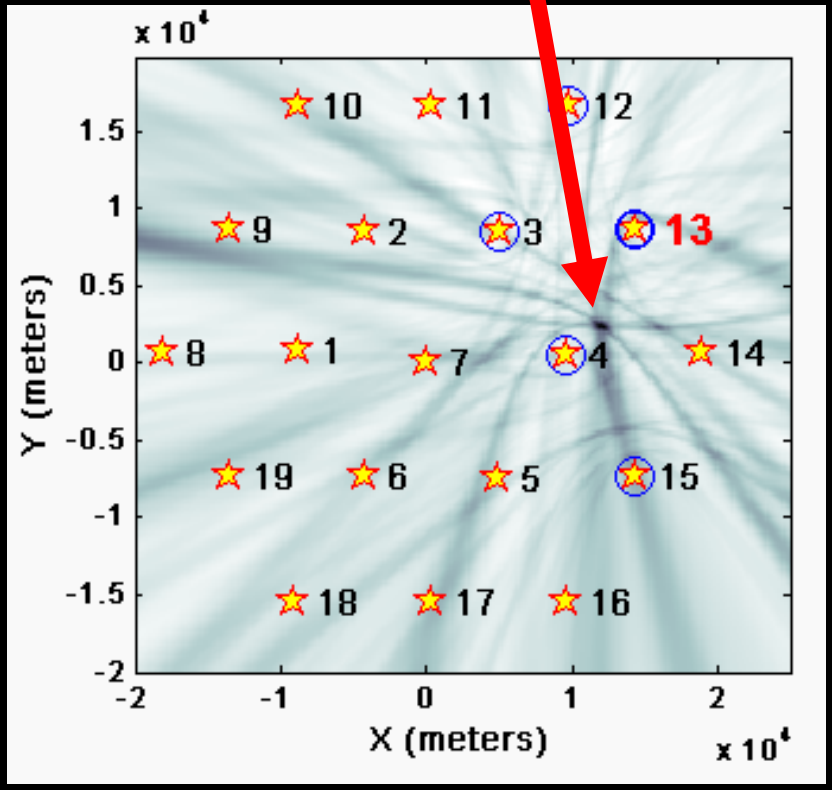
# Call Location on 19-Channel array – 14 Sept 2007




Location (x,y)

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